NIOSH Guide to the Selection and Use of Chemical, Biological, Radiological, Nuclear (CBRN) Self-Contained Breathing Apparatus

CONTENTS

I. SUMMARY FOR RESPIRATOR USERS

The U.S. Centers for Disease Control and Prevention's (CDC) National Institute for Occupational Safety and Health (NIOSH) certifies self-contained breathing apparatus (SCBA) for use by fire fighters and other first responders to terrorist attacks. NIOSH approval under the program signifies that an SCBA is expected to provide the necessary respiratory protection where an act of terror has released harmful chemical, biological, radiological, and / or nuclear (CBRN) agents into the air. Approvals are based on positive results from rigorous tests on sample units submitted to NIOSH by manufacturers, and from stringent evaluation of manufacturers' quality-control practices, technical specifications, and other documentation. This summary presents a brief overview of what the respirator user needs to know about the selection and proper use of the CBRN SCBA respirator.

In addition to the CBRN SCBA, other types of respirators are approved under the CBRN respirator class currently including the Full-Facepiece Air Purifying Respirator (APR) for emergency responders, and the CBRN Escape Hood Respirator for use by the general working population. Anticipated respirator approvals will include the CBRN powered air-purifying respirator (PAPR) and CBRN Combination Respirators, such as the CBRN Combination SCBA / PAPR. NIOSH is continuing its effort to draft and review selection and use guidance for all types of CRBN approved respirators.

CBRN SCBA respirators are intended for use by trained adult emergency responders for entry into (or escape from) terrorist agent contaminated environments. The specific chemical, biological, radiological and nuclear protections will be described and defined in Section II. (Detailed Guidelines for Use of CBRN Self-Contained Breathing Apparatus).

II. DETAILED GUIDELINES FOR USE OF CBRN SELF-CONTAINED BREATHING APPARATUS

A. Purpose

The purpose of this document is to provide users with guidance for the selection and proper use of self-contained breathing apparatus (SCBA) respirators certified by The National Institute for Occupational Safety and Health (NIOSH) for protection against chemical, biological, radiological, and nuclear (CBRN) agents. Proper use of respirators is a complex process requiring the knowledge of how to properly select a respirator for a specific contaminant or environment, assuring its proper fit, and being aware of the limitations of its protection. The information in this guide is intended to be administered by a knowledgeable respirator program administrator as part of an acceptable respiratory protection program in

accordance with the OSHA Respiratory Protection Standard 1910.134. The elements of a respiratory protection program will be described in Section X.

B. Background

CBRN respirator certification standards are the result of collaboration between several federal agencies, the United States Army, private certification organizations, and respirator user groups. The federal Interagency Board for Equipment Standardization and Interoperability (IAB) identified personal protective equipment that is currently available on the consumer market for responders' use and identified the development of standards or guidelines for respiratory protection equipment as a top priority. NIOSH, The National Institute for Standards and Technology (NIST), The National Fire Protection Association (NFPA), and the Occupational Safety and Health Administration (OSHA) entered into a Memorandum of Understanding defining each agency or organization's role in developing, establishing, and enforcing standards or guidelines for responders' respiratory protective devices. NIST initiated Interagency Agreements with NIOSH and the United States Army Soldier and Biological Chemical Command (SBCCOM) to aid in the development of appropriate protection standards or guidelines.

NIOSH established enhanced performance and design requirements for the certification of the CBRN SCBA. The three tiers of testing requirements are defined below.

- Tier 1. NIOSH approval for industrial operations, under 42 CFR Part 84, Subpart H.
- Tier 2. Compliance National Fire Protection Association Standard (NFPA) 1981 for 'Open Circuit Self Contained Breathing Apparatus for Fire Fighters'. The NFPA 1981 standard contains critical SCBA performance requirements unique to firefighting and operation in hazardous atmospheres including air flow (positive pressure and exhalation resistance, rough handling , high and low temperature, cyclical temperature, vibration, fabric flame and heat, thread melt, corrosion, lens abrasion) and communications.
- Tier 3. Special Chemical Penetration and Permeation tests under NIOSH 42 CFR 84.63(c).

1)Chemical warfare agent permeation and penetration resistance against Sarin (GB) and Distilled Sulfur Mustard (HD).

2) Laboratory Respirator Protection Level Test to ensure that the face-piece seal, the interface between the user and the SCBA, performs to an established NIOSH performance level.

C. Scope of Protection

To determine the certification criteria for CBRN respirators, an evaluation was performed using two primary considerations. These were a hazard assessment of possible Chemical Warfare Agent (CWA) incidents and an analysis of human factors requirements. The CBRN hazard assessment considered physical chemistry characteristics, vapor pressure-based saturation estimates, and use of terrorism venue modeling techniques to generate information about the potential hazards at an incident involving CWAs. For these assessments, the means of delivery and dissemination of the CWAs were considered combined with other variables including the amount of CWA and the environmental and physical characteristics of the area where the incident occurs.

In all, protection is provided for 139 Toxic Industrial Chemicals (TICs): 110 chemical, 13 biological, and 16 radiological / nuclear. The CBRN SCBA is a supplied-air, open-circuit, pressure-demand respirator, allowing it to be used in Immediately Dangerous to Life or Health (IDLH) environments, including oxygen deficient atmospheres.

Chemical Protection (Gas / Vapors, Chemical Particulates, and Chemical Warfare Agents)

The CBRN SCBA offers protection to 110 gas / vapors, chemical particulates, and Chemical Warfare Agents. Specifically categorized: 61 organic vapors, 32 acid gases, 5 nitrogen oxides, 4 base gases, 4 hydrides, formaldehyde, and 3 chemical particulates. Specific Chemical Warfare agent protection is provided for GB (Sarin gas), GA (tabun), GD (soman), VX, and HD (sulfur mustard gas).

Biological

Thirteen biological agents are addressed as part of the biological protection. They include Anthrax, Brucellosis, Glanders, Pneumonic Plague, Tularemia, Q Fever, Smallpox, Venezuelan Equine Encephalitis, Viral Hemorrhagic Fevers, T-2 Mycotoxins, Botulism, Ricin, and Staphylococcus Enterotoxin B.

Radiological and Nuclear

The respiratory hazard posed by nuclear or radiological material results primarily from the dispersion of radioisotopes carried on particulate matter (either solid or liquid aerosols). Sixteen radiological/nuclear agents addressed as part CBRN protection include Hydrogen 3, Carbon 14, Phosphorous 32, Cobalt 60, Nickel 63, Strontium 90, Technetium 99m, Iodine 131, Cesium 137, Promethium 147, Thallium 204, Radium 226, Thorium 232, Uranium 235 & 238, Plutonium 239, Americium 241.(7).

Immediately Dangerous to Life or Health (IDLH)

The CBRN SCBA is appropriate for use in conditions Immediately Dangerous to Life or Health (IDLH). The current NIOSH definition for an IDLH exposure condition, as stipulated in the NIOSH Respirator Decision Logic (DHHS [NIOSH] Publication No. 87-108, NTIS Publication No. PB-91-151183), is a condition "that poses a threat of exposure to airborne contaminants when that exposure is likely to cause death or immediate or delayed permanent adverse health effects or prevent escape from such an environment." The purpose of establishing an IDLH exposure concentration is to "ensure that the worker can escape from a given contaminated environment in the event of failure of the respiratory protection equipment."

The NIOSH Respirator Decision Logic uses these IDLH values as one of several respirator selection criteria. Under the NIOSH Respirator Decision Logic, the most protective respirators (e.g., a self-contained breathing apparatus equipped with a full facepiece and operated in a pressure-demand or other positive-pressure mode) would be selected for firefighting, exposure to carcinogens, entry into oxygen-deficient atmospheres, in emergency situations, during entry into an atmosphere that contains a substance at a concentration greater than 2,000 times the NIOSH REL or OSHA PEL, and for entry into IDLH atmospheres.

Oxygen-Deficient Atmosphere

High concentrations of some Toxic Industrial Chemicals (TICs) will cause displacement of oxygen in the contaminated area, thus resulting in an oxygen deficient atmosphere where the oxygen content falls below 19.5%. In atmospheres with an oxygen concentration below 19.5%, a supplied air breathing system is recommend by NIOSH to achieve adequate levels of oxygen.

The distinguishing feature of the self-contained breathing apparatus is that the wearer carries an independent supply of breathing air and is not connected to a stationary breathing gas source. All CBRN SCBA respirators are of open circuit design, meaning that exhaled air is exhausted to the atmosphere instead of recirculating it. A compressed gaseous breathing air supply is required in 42 CFR 84 to meet the applicable minimum grade requirements for Type I gaseous air set forth in the Compressed Gas Association Commodity Specification for Air, G-7-1, 1966 (Grade D air or higher quality). Compressed oxygen cannot be used in a device designed for compressed breathing air. In fact, 42 CFR 84 prohibits certification of any device designed to permit interchangeable use of oxygen and air. It is an acceptable safety rule that oxygen never be used in a device unless it is specifically designed for that purpose.

NIOSH defines an oxygen-deficient atmosphere as any atmosphere containing oxygen at a concentration below 19.5% at sea level. The minimum requirement of 19.5% oxygen at sea level provides an adequate amount of oxygen for most work assignments and includes a safety factor. The safety factor is needed because oxygen-deficient atmospheres offer little warning of the danger, and the continuous measurement of an oxygen-deficient atmosphere is difficult. At oxygen concentrations below 16% at sea level, decreased mental effectiveness, visual acuity, and muscular coordination may occur, and below 6% oxygen, death will result. Often only minor subjective changes are noted by individuals exposed to low concentrations of oxygen, and collapse can occur without warning (reference, NIOSH Respirator Decision Logic, p.21).

X. Service-Time

The Service Time of a CBRN SCBA respirator is indicated in the approval label

D. Awareness of Safety Features

Safety features on NIOSH certified CBRN SCBA respirators provide protection to the user. Among these are:

- Pressure gauges indicating the quantity of gas remaining in the cylinder
- End of (Remaining) Service Time Indicators (EOSTIs) that alert the user when the cylinder is low on air
- A universal air connector (RIC fitting) that facilitates air transfer to a distressed SCBA user (only required for CBRN SCBA approved under NFPA 1981, 2002 edition or more recent edition)
- Bypass valves, in case the first or second stage reducer fails and it is necessary to provide respirable air

a. Pressure Gauges

A pressure gauge indicating the quantity of gas remaining in the cylinder is required to be visible to the wearer at all times. The gauge may be designed as a mechanical gauge face or as a visual signal continuously displayed as part of a face-piece 'Heads-Up Display'.

b. End of (Remaining) Service Time Indicators

End of (Remaining) Service Time Indicators (EOSTIs) are required to alert the user when the cylinder is low on air. They may consist of either an audible alarm (whistle), a visually flashing LED light in the 'Heads-Up Display' of the face-piece, or a vibrating alarm. Depending on the requirements that were current during the year the unit was approved, some units may have more than one independently operating EOSTI, each of which will be recognized by different human senses.

c. RIC Fitting

The Rapid Intervention Crew/Company (RIC) Universal Air Connection (UAC) male fitting is a universal air connector that facilitates air transfer to a distressed SCBA user. Depending on the requirements that were current during the year the CBRN SCBA was approved, some units may not be equipped with a RIC fitting.

d. Bypass Valves for Regulator Failure

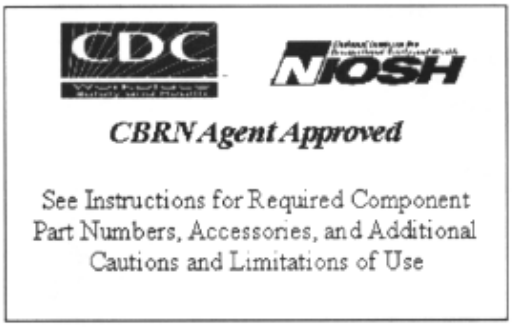
High-pressure air from the cylinder passes through both a first and second stage regulator and is reduced to a variable volume of air that can be delivered to the facepiece at a rate determined by the physical demands of the user. In the event that a regulator fails in the 'closed' position, air delivery will stop to the face-piece. The failed regulator can be 'bypassed' by opening the bypass valve, thus restoring flow to face-piece. The manufacturer's user instructions will specify how to use the bypass valve in the case on a regulator failure.

E. CBRN Approval Labels

Only respirators affixed with a CBRN Agent Approval label are certified by NIOSH for use in CBRN environments. To determine if a respirator is CBRN approved:

- Look to see if the CBRN Agent Approval label shown below is on the respirator. If a respirator is CBRN-approved by NIOSH, it will always carry this label. If this CBRN Agent Approval label is **not**

on the SCBA, the device is **not** approved by NIOSH for use in CBRN environments. **Check the Approval Label!**



- Additional information is provided through the NIOSH, matrix-style approval labels found in the "Instruction Manual" for the respirator. The "Instruction Manual" was shipped by the manufacturer with the respirator.

  - The approval number for a respirator approved for CBRN environments always includes a **CBRN** suffix (TC-13F-XXXXCBRN). If the approval number does **not** include a CBRN suffix, it is **not** certified by NIOSH for use by emergency responders in CBRN environments.

  - The complete CBRN assembly must be composed of **only** those component parts listed in the row with the CBRN approval number. Part numbers that are found **only** in the rows of the **non-CBRN** approvals **must not** be used as part of a CBRN SCBA assembly.

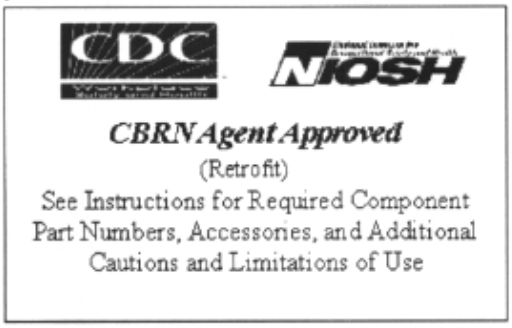
F. CBRN Retrofit Kits

NIOSH has implemented a program to approve retrofit kits for self-contained breathing apparatus (SCBA) for use by fire fighters and other first responders to terrorist attacks involving CBRN hazards. SCBA units that were placed in service prior to issuance of CBRN approval may be upgraded to CBRN approval status through this program. Respirator users can contact the manufacturer of their current SCBA to see if a NIOSH Approved CBRN SCBA retrofit kit is available.

In addition to the NIOSH CBRN Agent Approved label, CBRN SCBA retrofit upgraded kits contain the replacement components, parts, materials, and operating instructions required to upgrade an existing SCBA configuration to the approved CBRN configuration. The manufacturer's instruction manuals will provide a list of these components, as well as the following:

1. The minimum technician qualifications for performing the retrofit, and the level of manufacturer training required.
2. A list of SCBA models certified for use with the CBRN approved retrofit kit.
3. Detailed procedures for replacing components, parts, and/or materials required to establish the CBRN SCBA configuration,
4. Guidance concerning the CBRN SCBA operating instructions and differences from normal SCBA operating instructions,
5. Post retrofit inspections and tests required to verify work has been performed properly and that the CBRN SCBA operates in accordance with NIOSH, NFPA, and manufacturer requirements. As a minimum, the post retrofit inspection and test must verify leak tightness of assembly and components, positive pressure (static face piece pressure), exhalation resistance, bypass function, remaining service life alarm operation, pressure gauge accuracy, and flow performance,
6. Directions for installation of the NIOSH CBRN SCBA Retrofit Approval Label.

CBRN SCBA Agent Approved retrofit kits will contain a NIOSH CBRN Agent Approved label that must be affixed to the respirator after the upgrade is completed and the unit has passed the required post retrofit inspections and tests. Only if an SCBA retrofit kit is CBRN approved by NIOSH, will it be identified with a NIOSH CBRN Retrofit label. If the CBRN Agent Approved label is not present, the Retrofit kit is not approved by NIOSH for use by emergency responders in CBRN environments. **Check the Retrofit Approval Label!**



G. Cautions and Limitations

The following Cautions and Limitations apply to all SCBA CBRN respirators. Additional Cautions and Limitations may be applied by the manufacturer of the unit. In all cases, specific Cautions and Limitations as stated by the manufacturer must be strictly followed.

1) Use in conjunction with personal protective ensembles that provide appropriate levels of protection against dermal hazards.
2) Some CBRN agents may not present immediate effects from exposure, but can result in delayed impairment, illness, or death.
3) Direct contact with CBRN agents require proper handling of the SCBA after each use and between multiple entries during the same use. Decontamination and disposal procedures must be followed. If contaminated with liquid chemical warfare agents, dispose of the SCBA after decontamination.
4) The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation.

H. Overview of a Respiratory Protection Program

The Occupational, Safety, and Health Administration (OSHA) respiratory protection standard [29 CFR 1910.134] requires a written respiratory protection program to be administered by a trained program administrator. An established respirator program under the OSHA guidelines is also recommended in the NIOSH Guide to Industrial Respiratory Protection [NIOSH 1987], the American National Standard for Respiratory Protection (ANSI Z88.2-1992) [ANSI 1992], and the American Industrial Hygiene Association Respiratory Protection Manual [AIHA 1993].

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This section is intended to familiarize the respirator user and program administrator with the requirements of the OSHA standard (29 CFR 1910.134). One person (the program administrator) must be designated to manage all aspects of the program. All aspects of the respirator program must be written as Standard Operation Procedures (SOPs). The administrator must have sufficient knowledge, through appropriate training or experience, to develop and implement a respiratory protection program, and preferably, he or she should have a background in industrial hygiene, safety, health care, or engineering.

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The OSHA standard requires the following components as part of a complete respirator program:

- 29CFR1910.134(c)(1)(i) Procedures for selecting respirators for use in the workplace;

- 29CFR1910.134(c)(1)(i) (ii) Medical evaluations of employees required to use respirators;
- 29CFR1910.134(c)(1)(i) (iii) Fit testing procedures for tight-fitting respirators;
- 29CFR1910.134(c)(1)(i) (iv) Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;
- 29CFR1910.134(c)(1)(i) (v) Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;
- 29CFR1910.134(c)(1)(i) (vi) Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;
- 29CFR1910.134(c)(1)(i) (vii) Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;
- 29CFR1910.134(c)(1)(i) (viii) Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and
- 29CFR1910.134(c)(1)(i) (ix) Procedures for regularly evaluating the effectiveness of the program.

I. Face-Piece Fit

Importance of Facepiece Fit-Test and Fit-Check
A respirator will not provide its intended level of protection unless it fits the user properly. A Fit-Test is a method used to select the respirator that provides an adequate and comfortable fit. Determination of facepiece fit may involve either qualitative or quantitative tests (or both). The respirator program administrator is responsible for providing Fit-Tests to respirator users at regular, periodic intervals (e.g., annually) to ensure continued, proper fit. The respirator user should have the option to try different sizes of face pieces (for example: Small, Medium, & Large). The OSHA respirator standard [29 CFR 1910.134] mandates that masks, even for positive pressure units, be fit tested in the negative pressure mode.

A user Fit-Check is a method for determining whether a respirator has been properly donned (put-on) and adjusted properly. The Fit-Check should be performed every time the respirator is donned to ensure a proper fit. The seal of the respirator should be tested prior to entering a contaminated atmosphere by procedures recommended by the manufacturer of by the following these Fit-Check methods:

-Negative Pressure 'Fit-Check'- The inlet to the mask should be covered while the wearer inhales gently so the facepiece collapses slightly.
-Positive Pressure 'Fit-Check'- The test is conducted by closing off the exhalation valve and exhaling gently into the facepiece. The fit is considered satisfactory if slight positive pressure can be built up inside the facepiece without any evidence of outward leakage.

J. Inspection, Maintenance, Cleaning, Decontamination, and Storage

Respirator inspection, maintenance, cleaning, decontamination, and storage are essential parts of an overall respirator program. Always follow the manufacturer's guidance on these issues to ensure that the respirator continues to function properly. Wearing poorly maintained or malfunctioning respirators may cause a dangerous situation for the user.

Inspection and Maintenance
Users should follow the manufacturer's suggested routine inspection and maintenance schedules in order to retain the equipment's original effectiveness. All maintenance and repairs on a SCBA should be done by qualified personnel.

1) The respirator should be inspected at regular intervals before each use to determine if there are any mechanical problems with the apparatus. The user instruction manual provided with the respirator should give detailed guidance to assure that the respirator is in optimal working order.
2) The respirator facepiece should be inspected to ensure that it is not cut, torn, modified, deteriorated, or dirty. The elastomer should not be abraded and the sealing surface should be smooth and undamaged.
3) Straps, buckles, and harnesses should be in good working condition.

4) Inspect the inhalation and exhalation valves to see that they are in place, lying flat on the surface of the valve seat, and functioning properly.
5) The cylinder pressure gauge reading should be checked to ensure its operation
6) The cylinder valve should be turned on and checked for leaks for leaks; the low air alarm should be verified audibly
7) The high pressure line should be checked for leaks
8) The SCBA should be placed in service and checked for normal SCBA operation

Cleaning (When Used in Non-CBRN Environments)

When respirators are used for general industry type work where CBRN threats are absent, OSHA regulations require that respirator masks be regularly cleaned and disinfected. Respirators that are used by more than one person must be cleaned and disinfected after each use. Refer to the manufacturer's instruction manual for specific cleaning guidelines and recommended cleaning agents and sanitizers. Respirators cannot simply be immersed in cleaning solutions. Before cleaning and sanitizing, remove the following parts from the facepiece: filters, speaking diaphragms, valve assemblies, elastic straps, corrugated breathing tube, gaskets, and any other parts recommended by the manufacturer. The following are general guidelines for cleaning and sanitizing.

1) Wash the respirator in warm water containing a mild detergent at the temperature recommended by the manufacturer. NEVER use an organic solvent to clean a respirator.
2) Clean elastic straps with a bristle brush and mild detergent.
3) Sanitize and rinse the respirator in clean water.
4) Drain water from the respirator and allow it to air-dry in a clean and sanitary location.
5) Clean and sanitize all parts previously removed from the respirator.
6) Wipe the respirator and all its components with a cloth to remove any remaining water.

Storage

1) Respirators should be stored in a manner to protect them from dust, sunlight, heat, damaging chemicals, and excessive cold and moisture.
2) Face-pieces and exhalation valves should rest in normal positions. Impaired function will result if the elastomer sets in an abnormal position.
3) Store full facepiece respirators in plastic bags after drying and keep them in storage cabinets.

Decontamination

Decontamination of protective equipment and clothing is an important precaution to make sure that any contaminants that might have settled on the outside of protective equipment are removed before taking off gear. Decontamination sequences currently used for hazardous material emergencies should be used as appropriate for the level of protection employed.

Biological Response

This section deals with decontamination for a biological aerosol response only: Equipment can be decontaminated using soap and water, and 0.5% hypochlorite solution (one part household bleach to 10 parts water) can be used as appropriate or if gear had any visible contamination. Note that bleach may damage some types of firefighter turnout gear (one reason why it should not be used for biological agent response actions). After taking off gear, response workers should shower using copious quantities of soap and water. [Source: DHHS (NIOSH) Publication Number 2002-109, October 2001] http://www.cdc.gov/niosh/unp-intrecppe.htm CDC "Interim Recommendations for the Selection and Use of Protective Clothing and Respirators Against Biological Agents".

Sarin (GB)

This section deals with decontamination for an exposure to Sarin only:
Equipment: Use 5% solution of common bleach (sodium hypochlorite) or calcium hypochlorite solution (48 ounces per 5 gallons of water) to decontaminate scissors used in clothing removal, clothes and other items.
Source: NIOSH EMERGENCY RESPONSE CARD

http://www.bt.cdc.gov/agent/sarin/erc107-44-8.asp

Sulfur Mustard (HD)
This section deals with decontamination for an exposure to Sulfur Mustard only:

K. Commonly Asked Questions and Answers About CBRN SCBA Respirators

1. Is it always necessary to fit-check a respirator before each use?

2. How do I tell a new NIOSH CBRN SCBA respirator from a non-CBRN NIOSH respirator?

3. Will a non-CBRN NIOSH certified SCBA protect me from CBRN agents?

4. Do I need to dispose of or decontaminate my NIOSH CBRN SCBA after a response to potential CBRN agents?

5. How long can I use my NIOSH CBRN SCBA at the scene of a response?

The respirator should not be used beyond 6 hours after initial exposure to chemical warfare agents to avoid possibility of agent permeation.